One specimen only of what I believe to be a recent species of *Bellerophina* has occurred to me, from the middle of the Indian Ocean. From the general appearance of the shell, I should be inclined to place the Bellerophontidæ after the family Atlantidæ, among the Heteropods.

Genus Litiopa, Rang.

The species of *Litiopa* of Rang, or *Bombyxinus* of Bélanger and of Lesson, are not well known. One is named *saxicola*, another *pelagica*; but there is much confusion attending them. About a dozen species have been described, but require to be brought together and compared. This from the Indian Ocean appears to be different from the others, and may be thus characterized:—

Litiopa ventrosa, A. Adams.

L. testa ovato-conoidali, tenui, cornea, semipellucida, longitudinaliter minutissime striata; spira elata, apice obtuso; anfractibus $4\frac{1}{2}$, convexis, ultimo ventricoso, basi producta; apertura ovata; labio recto, antice truncato; labro margine regulariter arcuato.

Hab. Indian Ocean.

There was no *Sargassum* in the sea where this species was taken in the towing-net. It is a somewhat inflated, thin, horny shell, with the inner lip abruptly truncate, and the outer lip continued beyond the truncature, so that the aperture cannot be said to be truncate anteriorly.

Shanghai, China,
May 3, 1861.

XLI.—*On the Arrangement of the Families and Genera of* Chlorospermous Algæ. By Dr. John Edward Gray, F.R.S., V.P.Z.S., F.L.S. &c.

Having been recommended to change the course of my studies for a time, I have returned to my "old love," and have been devoting my vacation and my leisure time to the study of *Algæ* and the reading of the various books and papers on the subject which have come in my way. Thus, after an interval of forty years, I have ventured to prepare a paper on systematic botany, and to send to the 'Annals' some suggestions as to the arrangement of the Chlorospermous Algæ.

I always look back with pleasure to the time that I spent in collecting plants and in studying and teaching botany, and especially to the period when I was occupied in preparing the scientific part of the 'Natural Arrangement of British Plants,'

the work that first introduced the Natural System of plants to the student of English botany; for I need make no secret of the fact that I alone am responsible for that part of the work, since, though it was published under my father's name, he wrote the introduction only. Having in his youth studied British plants according to the system of Ray, he never would adopt the Linnæan system; and the only interest that he took in the scientific part of the work was that he considered the 'Genera Plantarum' of Jussieu as a revision and modification, according to the increase of knowledge, of the Rayian method, while he regarded the Linnæan system as only a dictionary by means of which the names of plants could be most easily discovered. The kind encouragement and assistance which I received during its preparation from M. DeCandolle, the father, and M. Dunal of Geneva (then in England), from Mr. R. A. Salisbury, and from my dear friends Edward Bennett, the late Secretary of the Zoological Society, and J. J. Bennett, now Keeper of the Botanical Collection in the Museum, and the use that the course of study it necessitated has been to me in after life, fully made up for all the obstruction and difficulties that were thrown in my way by other botanists, which delayed the appearance of the work for nearly a year, and for the ill-will exhibited towards me for many years after. But their opposition was of no avail: the Natural System has been established for years; and though the work was not a success—and, indeed, how could one be that attempted to introduce at once into English botany almost all that had been done on the Continent up to the period of its publication, and thus was so far in advance of the then state of botanical knowledge in England, where the study had been under the incubus of a blind attachment to the Linnæan system? —yet it has kept its ground; and the very opposition was useful to me by causing me to pay more attention to analytical studies, and to carry into zoology the knowledge, accurate terminology, and systematic method of study employed in the sister science which has led me to believe that the study of botany is the best introduction, even now, for the successful prosecution of the other branches of natural science.

The Melanosperms, and especially the Rhodosperms, have been well studied*. The Chlorosperms have been divided into a series of families or orders: but these families have not been arranged in satisfactory groups; at least, that is the conclusion

* Mr. Berkeley, however, observes, "Thuret describes and figures the antheridia of *Dictyota dichotoma*, and shows the necessity of considerable reformation in the classification of the Melanosperms, in consequence of the diversity of the reproductive organs."—*Introd. Crypt.* p. 566.

that I have arrived at. The last and best arrangement of the Melanosperms I have seen is Dr. Harvey's, published in his 'Nereis Boreali-Americana,' vol. iii. Feb. 1858. But the knowledge of the fructification of Algæ in general, and of this group in particular, is still so imperfect, and the accounts given of it by different authors are so conflicting, that it is by no means easy to reconcile them and bring them into a general system. The fructification of so small a proportion of the species has been examined and well described, that it is very doubtful whether many of the species which are referred to the different genera really belong to them; and in many genera the fruit has been so imperfectly described, that it is doubtful to what family they should be referred.

Under these circumstances, I feel that any attempt at arranging the families into larger groups must be attended with considerable uncertainty, and that we can only hope to advance towards a good arrangement by very slow degrees, adding very gradually to our knowledge as we proceed.

In forming groups, we ought to observe the resemblances of the species in their habits as well as in their properties and structure. It is nearly an impossibility to define with absolute strictness the confines of any group, of whatever value it may be, whether a genus, a family, or an order; and we must recollect that the distinctness of a group does not depend on the facility with which it can be characterized in a phrase or longer description. To take an example from zoology: no one doubts the distinctness of the Rabbits from the Hares; yet every zoologist and anatomist has failed to give a scientific character by which they can be separated—and most countries have their own species of hares or rabbits. I have known experienced sportsmen puzzled to say whether the variety of the Rabbit called the *Leporine* is a Hare or a Rabbit, and call some animals of the same litter hares, and others rabbits; yet they are most distinctly marked in their habits, as Mr. Bartlett justly observes. The Hares, which live in a "form" above ground, have the young born with the eyes open, covered with hair, and ready to feed themselves a few hours after birth, as is also the case with the Guinea Pig; while the Rabbits live in burrows, have the young born blind and naked, and dependent on their mother's milk for support for some time after birth. Now, if this is the case with animals so well known, what must be the imperfection of our knowledge regarding Algæ, which we can only observe at distant periods, and which are often so minute as to escape our sight without the aid of glasses, and many of which are greatly transformed in external appearance during their life and growth!

My observations lead me to think that the class may be divided into two subclasses.

Subclass I. MONOPHYTES.

The zoospores formed within the cells of the plant, isolated; each zoospore developing into a frond formed of a gradually-developed cell or cells like the parent.

Order I. Microsporæ.

The zoospores small, formed from the endochrome of a single cell.

Suborder I. *Siphoneæ.*

The plant of a single, tubular, simple or branched cell, not subdivided into joints, or at length furnished at the tip with a number of simple or branched articulated threads with cylindrical joints.

I. *The cell always undivided.* Siphoneæ veræ.

A. Zoospores in a distinct sporidium.

Fam. 1. Codieæ.

The cells simple, without any internal fibrous network, generally more or less interlaced together, forming a more or less spongy mass. Sporangium lateral, without external antheridia.

1. *Codium.*

Fam. 2. Halimedeæ.

The cell or plant branched, tufted, enclosed in an external coat of carbonate of lime.

"The *Halimedeæ* are generally barren; the fructifying individuals present little confervoid tufts, divided repeatedly above, and terminating in subglobose fastigiate (inarticulate) branchlets; the endochromes of these generally become organized, and produce innumerable active molecules, which doubtless are capable of propagating the plant." (Berkeley, Crypt. 160. f. 42.)

1. *Halimeda.* Frond branching, articulate; the joints flattened. (Harvey, Ner. Bor.-Am. 22. t. 40.)
2. *Udotea.* Frond fan-shaped, simple or cleft, on combined stems. (Harvey, Ner. Bor.-Am. 26. t. 40 c.)

B. Zoospores in the usual cells. Cell free, tufted, branched.

Fam. 3. Caulerpeæ.

The cell or plant free, tufted, more or less expanded as if branched on the sides.

1. *Caulerpa.* The cell filled with internal fibres.

2. *Bryopsis.* The cell slender, without any internal fibres.

3. *Chlorodesmus.* (Harvey, Ner. Bor.-Am. iii. 30. t. 40 c.)

II. *Cell or plant at first simply elongate (like the true* Siphoneæ*), at length developing at the apex a number of branched articulated filaments formed of elongate cells. Zoospore in the cell of the branched filament.* Siphoneæ barbatæ.

Fam. 4. **Valoniaceæ.**

* Stem tubular, vesicular, and branched.

1. *Valonia.*

** Stem nodulose, with whorls of jointed, byssoid, deciduous fibrilli, and a head of radiating larger cells, which are also deciduous.

2. *Acetabularia.* Cell of head radiating, united. (Harvey, Ner. Bor.-Am. t. 42 A.)

3. *Cliftonella.* Cell of head radiating, free; stem not perforated. (*C. calyculus* (*Polyphysa Cliftonii*, Harvey ?).)

4. *Polyphysa.* Cells of head clustered. (*P. penicillus.* Harvey, Ner. Aust. t. 11.)

*** Stem annulated, covered with a tuft of forked jointed filaments.

† *Head a tuft of slender filaments.*

5. *Penicillus.* Stems very slender, many interlaced together, forming a thick stipes. (*P. arbusculus*, Harvey, Ner. Aust. t. 22.)

6. *Chamædoris.* Stem single, separate, thick, annulate. (*C. annulata*, Harvey, Ner. Bor.-Am. 42. t. 42 B.)

†† *Head branched; branches like the stem, annulate.*

7. *Ayyohnia.* (Harvey, Ner. Aust. t. 5.)

††† *Head a reticulated frond.*

8. *Struvea.* (*S. macrophylla*, Harvey, Ner. Aust. 1. t. 7. *S. plumosa*, Harvey, *ib.* t. 32.)

Suborder II. *Arthromorpha.*

The cells many, united together, forming a chain-like filament, one at the end of the other; sometimes in the older parts, as the stems, the threads are incorporated into a solid or tubular axis.

A. The zoospores developed in some dilated cells, forming a beaded, thread or in a large cell situated at the end of the branches or branchlets.

* *The spores in beaded threads radiating from the centre, and densely packed into a spherical ball immersed among the branchlets.*

Fam. 1. **Batrachospermeæ.**

Frond gelatinous, clothed externally with slender articulated ramuli on a solid stem of densely interwoven threads.

Dr. Harvey thinks these balls are rather buds than spores, the plant and fructification having great resemblance to *Helminthocladiæ* among the Rhodosperms.

1. *Batrachospermum.*

** *Sporidia solitary on the branchlets.*

Fam. 2. **Thoreæ.**

The frond gelatinous, clothed with a number of byssoid scattered ramuli on a cellular stem formed of densely interwoven threads.

1. *Thorea.*

Fam. 3. **Lemaneæ.**

Frond cartilaginous, solid or hollow, with a cellular peripheral layer and internal tufts of articular branched threads bearing a sporangium.

1. *Lemanea.*

"The threads are at first precisely like those of a *Conferva*; certain joints, however, are protruded from the sides, after the manner of the first division of the threads in *Cladophora*; these rapidly increase, both in length and breadth, by means of transverse and vertical division; a cavity is formed in the centre; the walls are lined with large transparent cells, from which articulated threads are sent forth horizontally into the cavity either from every point of the surface or in whorls, insomuch that the structure is almost that of a *Cymopolia* or *Batrachospermum* turned inside out." (Berk. p. 137.)

"The spores at first vegetate into confervoid, slender, jointed filaments, with long joints containing a spirally-arranged endochrome; at length thick branchlets spring from the cells, which soon acquire rootlets at their base and grow into the perfect frond." (Thwaites, Linn. Trans.)

Fam. 4. **Dasycladeæ.**

Frond green, naked or coated with carbonate of lime, having a unicellular simple or branched axis, which is whorled throughout its whole length with articulated ramuli. Spores spherical, developed in proper fruit-cells.

* *Sporidia lateral, at the base of the branchlet.*

1. *Dasycladus.* (Harvey, Ner. Bor.-Am. 35. t. 41 B.)

** *Sporidia at the top of the branchlet.*

2. *Cymopolia.* (Harvey, Ner. Bor.-Am. 33. t. 41 A.)

Dasycladus has been illustrated in Debès and Solier's memoirs, and is also figured by Kützing, and seems rather a compound *Conferva* and *Vaucheria.*

Fam. 5. Chætophoreæ.

Frond green, filiform, articulated; branches invested with gelatine of a more or less determinate form. Cell filled with endochrome; tips of the filaments attenuated, jointed. Sporangium globose, on the sides or end of the branchlets.

1. *Chætophora.* Filaments aggregate, clustered, combined into a gelatinous frond of definite form. *C. endivæfolia.* Sporidia lateral. (Hassall, t. 9. f. 1, 2.) ?*C. dilatata.* Sporidia terminal. (Hassall, t. 13. f. 2.)

In *Chætophora* the threads are studded with globose lateral cysts.

Müller informs us that in *C. tuberculosa* he has repeatedly seen two kinds of cysts—one scarlet, and constituting *antheridia*, the other larger, and at length producing spores.

2. *Draparnaldia.* Filament separate, dimorphous. Cells of stem and branches hyaline cross-banded, of ramuli filled with endochrome. *D. glomerata.* (Hassall, t. 13. f. 1.)

"In *Draparnaldia* the diaphanous prolongations of the filament are septate, each consisting of a series of elongated cells. The *sporangia* also in *Draparnaldia glomerata* and *Chætophora elegans*, in which species we have observed them, are formed within the original cell of the ramuli, causing the latter to assume a moniliform appearance. Quaternate *zoospermata*, which are most probably gemmæ, likewise occur in these species, as well as in those of the genus *Stigeoclonium* of Kützing." (Thwaites in Harvey, Ph. Brit. t. 226.)

Fam. 6. Blodgettiaceæ.

The genus *Blodgettia* of Harvey, Ner. Bor.-Am. 46. t. . *B. confervoides*, which he thus describes:—

"Fronds cæspitose, branching, confervoid, articulate; articulations unicellular, filled with grumous viscid endochrome. The cell-wall formed of separable membranes, the outer of which are hyaline and homogeneous, the innermost traversed by parallel longitudinal veinlets. Spores serrated, in moniliform strings, and developed from the veinlets of the inner cell-wall." Appears to be the type of a new family.

B. The zoospores are small and numerous, produced in the cells of the frond, which are of a uniform structure.

Fam. 7. Confervaceæ.

Frond green, filiform, articulated, destitute of any investing

gelatine, attached or, more rarely, free. Cells elongate, mostly uniform in size. Endochrome filling the cavity of the cells. Zoospores minute, undefined, numerous in each cell.

** The stem branched.*

1. *Cladophora.*

*** The stem unbranched.*

"A large quantity of *Confervaceæ* consist of simple unbranched articulate threads, increasing in length by constant division of the endochrome, and propagated either by the rupture of the thread or by active granules formed within these articulations, and escaping by a regular aperture." (Berkeley, Crypt. p. 133.)

2. *Chætomorpha.* (*C. melaginium,* Harvey, Ph. Brit. t. 99 *a.*)

3. *Hormotrichium.* (*H. Younganum,* Harvey, Ph. Brit. t. 328.)

4. *Rhizoclonium.* (*R. riparium,* Harvey, Ph. Brit. t. 238.)

The following genera, having a frond of filmy network formed of dichotomously-branched anastomosing filaments, should, perhaps, be arranged in this family.

5. *Microdictyon.* (*M. Agardhianum,* Harvey, Ner. Aust. i. t. 50.)

6. *Talarodictyon.* (Payen, Crypt. 24.)

7. *Anadynomene.* (*A. flabellata,* Harvey, Ner. Bor.-Am. 49. t. 41 A.)

See also *Cladophora*? *anastomosans,* Harvey, Ner. Aust. ii. t. 111.

Suborder III. *Solenomorpha.*

The cells isolated, more or less uniform, often forming a beaded series, contained in an inarticulate tubular sheath or in a gelatinous frond formed of the more or less coalesced tubular sheaths. The threads are simple, or only appear branched from apposition, and contain the zoospores. The cells or series of cells sometimes divide longitudinally.

Fam. 1. Oscillatoriaceæ.

The cells compressed, disk-like, very short; they multiply by transverse division. Threads articulated, simple, or branched by the division of a metamorphosed cell, more rarely by the protrusion of the central cord consequent on the rupture of its outer coat. Cells generally very narrow. Propagation (where the mode of fructification has been ascertained) by means of zoospores.

"It was once supposed that their endochromes were totally different from those of *Confervæ,* consisting merely of circular disks filling up a common tube, and finally expelled from it. There is, however, no doubt that they are of the same nature as

in other allied Algæ, that each is contained in a distinct sac, and that multiplication takes place in the same way, by division of the endochrome and formation of a new membrane round each division." (Berkeley, Crypt.)

** Filaments free, tufted, erect.*

1. *Calothrix.* (*C. confervicola,* Harvey, Ph. Brit. t. 254.)

*** Filaments free, decumbent, simple.*

2. *Lyngbya.* (*L. majuscula,* Harvey, Ph. Brit. t. 62.)
3. *Oscillatoria.* (*O. litoralis,* Harvey, Ph. Brit. t. 105 A.)

**** Filaments branched by apposition.*

4. *Petalonema.* (*P. alatum,* Hassall, t. 68. f. 6.)
5. *Scytonema.* (*S. myochrous,* Hassall, 237. t. 68. f. 2.)

***** Filaments bundled in a sheath.*

6. *Microcoleus.* (*M. anguiformis,* Harvey, Ph. Brit. t. 249.)
7. *Schizosiphon.* (*S. Warreniæ,* Harvey, Ph. Brit. t. 316.)

****** Filaments radiating from a centre, and having a spherical cell at the root.*

8. *Rivularia.* (*R. plicata,* Harvey, Ph. Brit. t. 315.)

Fam. 2. **Nostochineæ.**

"The cells subglobular, increased by transverse and longitudinal division. Threads very slender, moniliform, invested with gelatine, which is at length, to all appearance, common to the mass, but at first appertains to each individual thread. Propagation by division of the threads or by zoospores." (Berk. p. 139.)

"The threads, broken up into fragments, burst through the common envelope and become dispersed in the water; in this condition they are endowed with spontaneous motion. These fragmentary threads divide longitudinally and transversely, at last constituting a bundle of new threads, which gradually, by increase of the gelatinous or filamentous element, assume the normal form of the species." (Berkeley, p. 140; see also Harvey, Ner. Bor.-Amer. p. 111.)

"It has been asserted that they are nothing but a state of Lichens. It is true that the fronds of the Collemal Lichens do contain gonidia arranged in little necklaces; but this appears to be a mere case of analogy." (Berkeley, Crypt. p. 141.)

a. *Filaments invested in a mucous matrix forming a defined mass or frond.*

1. *Nostoc.*
2. *Monormia.* (*M. intricata,* Hassall, 286. t. 75. f. 11.)

b. *Filaments not enclosed in gelatine having a defined form.*

3. *Spirillum.* (*S. Jenneri,* Hassall, 277. t. 75. f. 5.)
4. *Aphanizomenon.* (*A. incurvum,* Hassall, 280. t. 76. f. 6.)
5. *Sphærozyga.* (*S. Carmichaelii,* Harvey, t. 113.)
6. *Spermosira.* (*S. Harveyana,* Harvey, t. 173.)

Suborder IV. *Phyllomorpha.*

Cells united together side by side, forming an expanded flat or tubular frond; the cells parting into four, eight, or sixteen cells by transverse and longitudinal section.

Fam. Ulvaceæ.

"Cells divided vertically and horizontally, so as to make a frond-like or tubular membrane. Propagation by zoospores furnished with flagelliform cilia." (Berkeley, p. 162.)

a. *Frond and endochrome purple.*

1. *Porphyra.* Frond leaf-like, flat. (*P. vulgaris,* Harvey, Ph. Brit. t. 211.)
2. *Bangia.* Frond filiform, tubular. (*B. fusco-purpurea,* Harvey, Ph. Brit.)

These genera, according to Thuret, have *antheridia* like Rhodosperms. (See Ann. Sc. Nat. Oct. 1856.)

b. *Endochrome and membranous frond green.*

3. *Enteromorpha.* Frond tubular, simple or branched, of a single series of cells. (*E. intestinalis,* Harvey, Ph. Brit. t. 154.)
4. *Phycoseris.* Frond membranous, of one series of small cells. (*P. Linza,* Harvey, Ph. Brit. t. 39.)
5. *Dictyosphæria.* Frond membranous, of one series of large vesicular cells; the cells are quaternately divided. (*D. favulosa,* Harvey, Ner. Bor.-Am. t. 44 B.)
6. *Ulva.* Frond membranous, of two strata of small cells. (*U. lactuca,* Harvey, Ph. Brit. t. 243.)

c. *Endochrome and gelatinous frond green.*

7. *Tetraspora.* (*T. lubrica,* Hassall, 300. t. 78. f. 10.)
8. *Prasiola.* (*P. calophylla* (*Ulva*), Hassall, 298, t. 677. f. 1.)
9. ?*Merismopoedia.* (*M. punctata,* Hassall, 299. t. 84. f. 6.)

Greville observes that sometimes there is only a single line of quaternate granules in the narrowest frond, and as many as ten or twelve in the broadest, of *Ulva calophylla* (see Algæ Brit. 176), and he states that the same difference occurs in *Bangia,* giving

some fronds much the appearance of a Conferva (p. 177). Dr. Hicks, from observing the same fact, seems to think that *Lyngbya muralis*, *Schizogonium*, and *Prasiola* are only states of the same species. If this is the case, as the true *Lyngbyæ* have not been observed to change into any other plant, *L. muralis* must be the young state of a plant putting on the form of a genus of a different group (see Quart. Journ. Micros. Science, July 1861). The development of *Enteromorpha* and of *Ulva clathrata* have been described by Hassall (Brit. Freshwater Algæ, pp. 296, 304), and also by Greville in his 'British Algæ.'

Order II. Macrosporæ.

The zoospores large, formed by the union of the endochrome of two neighbouring cells in the same or contiguous threads, or by the division of a single primary endochrome of a single cell.

Suborder I. *Trichomorpha.*

The plant formed of a thread-like series of cells. The propagation entirely, or at least chiefly, by zoospores. The endochrome generally assumes some definite arrangement, often forming one or more spirals or stars.

Fam. 1. Zygnemaceæ.

Filaments free, floating, simple, articulated, thread-like, composed of cylindrical seriated cells. Zoospores formed by the union of the endochrome of two cells, simple.

A. The zoospore formed by the union of the cells of two different threads.

a. *The conjugating filaments parallel, or nearly so, to each other.*

1. *Zygnema.* Endochrome in spiral lines; zoospore in the cells. (*Z. nitida*, Hassall, t. 22. f. 1, 2.)
2. *Tyndaridea.* Endochrome in two stellate masses; zoospore in the cells. (*T. cruciata*, Hassall, t. 38. f. 1.)

b. *The conjugating filaments angulated, bent, and coalescing at the bend.*

3. *Mougeotia.* (*M. genuflexa*, Hassall, t. 40. f. 2.)

B. The zoospore formed by the union of the endochrome of the cells in the same thread.

4. *Rhynchonema.* Endochrome in a spiral thread; thread generally bent at an angle where the spore is formed. (*R. rostratum*, Hassall, t. 33. f. 1.)

Fam. 2. Thwaitesieæ.

Filaments free, floating, simple, articulated, thread-like, composed of seriated cylindrical cells. The zoospore formed by the

union of the endochrome of two cells, which at length become divided crosswise into four spores.

** The filaments parallel.*

1. *Thwaitesia.* (Berkeley, Crypt. 152. f. 39.)

*** Filaments bent, united at the angle.*

2. *Mesocarpus.* (Payen, Crypt. 26. f. 114; Hassall, t. 42. f. 1.)
3. *Staurocarpus.* (Payen, Crypt. 26. f. 113; Hassall, t. 47. f. 1.)

Fam. 3. Œdogoniaceæ.

The frond rooted, simple, articulated, thread-like, composed of a series of equal cells filled with endochrome; some of the cells eventually becoming dilated and swollen. Spore formed by the division of the endochrome of a fertile cell; the cell separates into two half-cells by a transverse partition. The zoospore is formed in one half; the other half lengthens to its proper size, and divides again; and this process is often repeated. (Thwaites, Ann. Nat. Hist. xvii. 333; Berk. Crypt. p. 151. f. 38.)

1. *Œdogonium.* (*Vesicularia capillaris,* Hassall, t. 50. f. 1, 2.)

"The divided portion of the endochrome which does not bear a spore swells, increases in length, is itself divided, and the posterior half becomes fertile; and this process may be repeated till a chain of spores is formed. The endochrome in the fertile half-cell, whether mixed with that of the neighbouring cell or not, contracts into a globular or elliptical mass, acquires a distinct envelope, most probably after impregnation; and this forms a spore. In some instances these spores are perfectly quiet, but in others they have ciliated appendages at one extremity, by means of which they move about with an apparently spontaneous motion. The spores after a time become attached at one end by two or three root-like processes, the endochrome divides, and new threads are formed.

"The upper cells of the antheridium of *Œdogonium* produce two elliptical bodies, which pass into the cavity of the spore-cell and there effect the impregnation of the spores. The antheridia are first formed within special cells, from which they escape and move about by means of a coronet of cilia, till they fix themselves upon the spore-cell." (Pringsheim, in Berkeley, Crypt. p. 565.)

Fam. 4. Bulbochætaceæ.

"Threads articulate, branched; fertile branchlets bulb-shaped, surmounted by a long inarticulate hair-like point. Endochrome apparently impregnated by bodies provided in little antheridia seated on the wall of the fertile cells, dividing at length into four ovate zoospores." (Berkeley, Crypt. p. 156.)

"The endochrome of the bulb soon becomes compact, and at the same time little processes like those of *Œdogonium* are developed on the surface; and the wall itself becomes fissured, apparently to admit the contents of the microgonidia. The endochrome then acquires a membrane and appears as a perfect spore." (Berkeley, Crypt. p. 156.)

In the genera *Ochlochæte, Bulbochæte,* and *Coleochæte,* "the setæ, when present, are rigid continuous tubes; and the fruit, so far as has been observed, is not contained within an original cell of the filament, but each sporangium is in a new cell, formed, it is true, by the elongation of an original cell, but subsequently separated from it by a septum. This occurs in *Tiresias* (*Œdogonium*), *Bulbochæte,* and *Coleochæte.*" (Thwaites, in Harvey, Ph. Brit. t. 226.)

1. *Bulbochæte.* (*B. setigera,* Hassall, t. 54. f. 1–4.)
2. *Coleochæte.* (*C. scutata,* Hassall, t. 77. f. 6.)
3. *Ochlochæte* (*O. histrix,* Harvey, Ph. Brit. t. 226) may also belong here; but the fructification is unknown.

Chætophora pisiformis is not congeneric with *C. elegans,* Ag.: it has the fruit and setæ of *Coleochæte,* from which it would seem to be separated only by its erect, free, not adpressed filaments. There can be little doubt, therefore, that *Chætophora tuberculata* is equally a *Coleochæte.* (Thwaites, in Harvey, Ph. Brit. t. 226, note.)

Suborder II. *Siphonomorpha.*

The plant a single, elongate, contiguous, tubular cell, more or less interlaced, on which is developed a sporangium. The zoospores are formed by the union of these two cells on the same plant.

Fam. 1. Vaucheriadeæ.

Cell simple, tubular, with a distinct ovate sporangium and a lateral process (*antheridium*), which temporarily conjugates and produces a globular zoosperm. (See Karsten, Ann. Nat. Hist. viii. 1861, p. 86, t. 9 A.)

1. *Vaucheria.*
2. *Saprolegnia?*

Suborder III. *Callomorpha.*

Plant consisting of isolated cells, separate, or simply cohering together in elongated simple or branched threads. Cells rarely conjugating.

Mr. Berkeley justly observes "that Desmidiaceæ and Diatomaceæ may grow for years without forming a spore, the propagation being carried on meanwhile by mere division" (p. 116).

A. Cells dividing by a simple dissepiment.

Fam. 1. **Palmelleæ.**

The cells (like *Protococcus*) are laid without order, or in a quaternary manner, in large numbers, within a common gelatinous false frond.

"Cells free, or surrounded by a gelatinous mass, sometimes stipitate; propagation by the division of the endochrome, which is mostly quaternary, and sometimes transformed into spores." (Berkeley, p. 114.)

In *Elæocapsa Hookeri*, which is found in chalk-clefts in Norfolk, "the inner membrane repeatedly bursts through the outer, though always adherent behind, so as to form a gelatinous mass of annulated threads, with a bright eye at the tip of each. The endochrome is occasionally bipartite, and then each new membrane acts for itself." (Berkeley, *l. c.* p. 117. f. 28.)

"The scattered cells in the early stages of *Palmella* are connected by slender gelatinous threads radiating from a larger central cell; the cells conjugate, two contiguous cells being united by a narrow connecting tube, which soon enlarges, and through which the contents of the two cells are mixed, and thus a sporangium is formed, the membranes of the original cell being absorbed." (Thwaites, Ann. Nat. Hist. ii. iii. n. s.)

"In *Palmoglœa Meneghinii*, at least, there is a distinct coupling of neighbouring spores; and Brébisson has noticed a similar fact in *Coccochloris protuberans* and *P. rubescens*, while the transparent peduncles point in the direction of certain Diatomaceæ.

"According as the endochrome divides vertically or transversely the mass increases in width or length; and as the divisions alternate after some tolerably fixed law, a network of greater or less width is formed, according to the proportion of vertical and horizontal division." (Berkeley, 119.)

** Cells in a gelatinous mass.*

1. *Palmella.*

*** Cells in a confervoid simple or branched tubular filament.*

2. *Hormospora.* (*H. ramosa*, Harvey, Ph. Brit. t. 213.)

3. *Hydrurus.* (*H. penicillatus.*)

B. Cells dividing by the formation of two new central half-cells.

Fam. 2. **Desmidiaceæ.**

"Green; the cells membranous, free from silex. Cells free, or forming brittle threads or minute fronds; increasing by the formation of two half-cells in the centre or medial line, so that the two new cells consist each of a new and old half-cell. Spores

generated by the conjunction of two distinct individuals." (See Berkeley, p. 120. f. 31, 32.)

"All writers agree in their increase by the partition of the mother-cell, accompanied by the growth of two new half-cells: in many cases this division goes no further, but each half with its new lobes grows into a perfect whole, and again divides. But this is by no means the case in all; for the two original halves do not always separate, but remain united with their progeny for many generations, thus forming a filiform body, in which the two primary halves are at each extremity and the youngest in the middle of the thread,—a mode of increase which we shall meet with again in the following tribe." (Berkeley, p. 17. f. 7, p. 121. f. 30 *a*, *b*.)

There is no difficulty in pointing out the passage between the Desmidieæ and the Zygnemidæ; for the genus *Spirotænia* has all the appearance of being a separate joint of a *Zygnema*.

Fam. 3. Diatomaceæ.

Endochrome yellow-brown. Cells covered with a silicious coat, often beautifully sculptured. Propagation and division of cells as in Desmidiaceæ.

"As in Desmidiaceæ, there are solitary species, and others grouped into lines and membranes; and in a few which have been observed to produce new plants by means of spores, the new production does not exhibit at first the normal character of the species." (Berkeley, p. 124.)

"The Diatomaceæ were long believed to be animals, and this view has more especially been maintained by Ehrenberg; but the discovery of the coupling of fronds by Mr. Thwaites, and the confirmation of this fact by myself, Mr. Broome, and others, leave no doubt that they belong to the same order of beings as Desmidiaceæ and Conjugatæ." (Berkeley, p. 126.)

The genera have been divided into three groups: first, those with smooth and transversely striated frustules; the second, with vittate, and the third with areolar frustules (p. 129).

The British species have been well described and beautifully figured in Dr. Smith's work, and the whole subject has been revised in Pritchard's 'Diatomaceæ;' but it appears to me that the arrangement of Smith is more in conformity with nature than that now proposed, which appears to be intended solely to enable the microscopist to name the species in the easiest manner from the isolated or prepared specimens that come into his hands.

Subclass II. POLYPHYTES.

The zoospores aggregated into a definite form, and often covered with a membranous or gelatinous coat; each zoospore

developing within itself a similar aggregate group of minute zoospores, which enlarge and afterwards become free.

Fam. 1. Hydrodictyeæ.

Frond green. Zoospores naked, oblong, united at the ends into a saccate net with polygonal meshes, each side of the mesh being formed of a single zoospore.

1. *Hydrodictyon.*

"The granular mass gives rise, at a certain period of growth, to a number of elliptical grains endowed with active motion; these become attached to each other by their extremities so as to form a network; union takes place between the several bodies, and in process of time a new individual is formed, which becomes free by the absorption of the external wall." (Berkeley, p. 238.)

Fam. 2. Pediastreæ.

Frond green. Zoospore naked, free, oblong or angular, united side by side into an expanded frond.

The passage from the family Hydrodictyeæ to the Pediastreæ is easy by the genus *Serastrum*, in which the cells form a small oblong sphere. Indeed the resemblance is so great, that it has been suggested that the genus *Hydrodictyon* should be removed to the group of Desmidieæ to be near that genus.

** Cells fusiform or elliptical.*

1. *Scenedesmus.* (*S. quadricauda,* Ralfs, t. 31. f. 12.)

*** Cells angular, forming a flat disk.*

2. *Pediastrum.* (*P. ellipticum,* Ralfs, t. 31. f. 10.)

3. *Cœlastrum.*

**** Cells angular, forming a hollow sphere.*

4. *Serastrum.*

Fam. 3. Volvocineæ.

Frond green. Zoospores circular or square, enclosed in a membranous or gelatinous cyst of definite form.

"Propagating by the repeated segmentation of the contents of the old cells into a definite number of portions or 'gonidia,' which are either still or for a time mobile, and which are either arranged according to the typical plan within the parent-cell, and by its bursting set free as a new frond or family, or become so arranged without the parent-cell, but still involved in its inner membrane, the whole having emerged by a transverse fissure." (Pritchard, Diatom. p. 753.)

The number of cells is always constant in young fronds

without exception. In older specimens one or more cells are lost, and the frond becomes therefore apparently irregular (*l. c.* 26).

1. *Pandorina* (Pritchard, Diat. pp. 157, 517, t. 19. f. 59–69) and *Eudorina* are the same.
2. *Gonium.* (Pritchard, Diat. pp. 152, 517, t. 19. f. 32–37.)
3. *Volvox.* (Pritchard, Diat. pp. 180, 526, t. 20. f. 32–47.)
4. *Stephanosphæria.* (Pritchard, Diat. p. 529, t. 19. f. 38–58.)

According to Dr. Hicks, the *Volvox* is perpetuated in two ways: 1, by the encysted cell or oospore; 2, by the motionless segment of the zoospore, which clearly has its homologue in many Algæ, and is free from motion because without cilia, and thereby distinguished from *zoospores.* (Quart. Journ. Microscop. Science, 1861, p. 283, t. 9. f. 1–11.)

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

June 20, 1861.—Major-General Sabine, Treasurer and Vice-President, in the Chair.

"On the Anatomy and Physiology of the Spongiadæ" (Part II.), by J. S. Bowerbank, LL.D., F.R.S., F.L.S., &c.

This paper is a continuation of the first division of the subject, published in the Phil. Trans. for 1858.

In the second part of this division the author treats of the keratode or horny substance of the skeleton, as regards both its physical and chemical characters, with a view of establishing the animal nature of that substance.

In the third part the membranous tissues are described under two heads :—

1st. Simple membranous tissues analogous to those of the basement membranes of the higher classes of animals; and

2nd. Compound membranous tissues. These structures consist of simple membranous tissue combined with primitive fibrous tissue. Their most simple forms exist in the membranes lining the interstitial cavities of the sponge and in the dermal membrane.

In the fourth part the fibrous tissues are described as consisting of three principal divisions.

1st. Primitive fibrous tissue. These structures are exceedingly minute, and form an important element in the construction of the compound membranous tissues of the animal.

2nd division. The fibres of the skeleton are described under the following heads :—

1st. Solid simple keratose fibre.